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Seeing better, intubating better: smart video vs. Macintosh laryngoscopy

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Abstract

Background: Difficult airway management remains a critical challenge in anaesthesia and emergency care. Smart video laryngoscopes have been developed to enhance glottic visualization and improve intubation success, but comparative evidence in predicted difficult airways remains limited. **Aim:** To compare the effectiveness of a smart video laryngoscope with a conventional Macintosh laryngoscope in adults with predicted difficult airways.

Methods: A prospective comparative study was conducted at Dayanand Medical College, Ludhiana, Punjab, from March to August 2025. Adults with an El-Ganzouri Risk Index score ≥4 were randomly allocated to either video laryngoscopy (Group V) or Macintosh laryngoscopy (Group M). Primary outcome was first-attempt intubation success. Secondary outcomes included glottic visualization, time to intubation, haemodynamic response, and peri-intubation complications.

Results: Group V demonstrated significantly higher first-attempt success (91.7% vs. 68.3%), shorter intubation time, and better glottic visualization with higher POGO scores. Adjunct use and complications such as hypoxia, mucosal injury, and esophageal intubation were significantly lower in Group V.

Conclusion: Smart video laryngoscopy offers clear advantages over conventional laryngoscopy in predicted difficult airways. Its routine integration into airway algorithms may improve safety and clinical outcomes.

Keywords: Video laryngoscope, Difficult airway, Macintosh laryngoscope, Intubation success, Airway management

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Introduction

Difficult airway management remains a major challenge in anaesthesia, with failed or multiple intubation attempts leading to hypoxia, airway trauma, cardiovascular instability and cardiac arrest [1]. Conventional Macintosh laryngoscopy requires alignment of the oral, pharyngeal and laryngeal axes and often provides a suboptimal glottic view in predicted or unanticipated difficult airways. Videolaryngoscopes improve laryngeal visualisation and have been associated with higher first-pass success and fewer oesophageal intubations in adults, particularly in high-risk and critically ill populations [1, 2]. Recent randomized trials and meta-analyses also suggest that videolaryngoscopy shortens intubation time, reduces airway-related complications and enhances success in patients with elevated El-Ganzouri Risk Index (EGRI) scores and simulated difficult airway scenarios [3, 4]. Smart video laryngoscopes integrate high-resolution cameras, recording, and sometimes AI-enhanced guidance, allowing real-time teaching, post-procedure review and standardized documentation of difficult airway events. The aim of the present prospective study is to compare a smart video laryngoscope with conventional Macintosh laryngoscopy in adult patients with predicted difficult airways, in terms of first-attempt success rate, time to intubation, glottic view quality, haemodynamic response and airway complications.

Methods:

The present prospective comparative study was conducted in the department of Anaesthesiology and the department of Emergency Medicine at Dayanand Medical College, Ludhiana, Punjab, over a six-month period from March 2025 to August 2025. After obtaining Institutional Ethics Committee approval and written informed consent, adult patients aged 18–65 years scheduled for elective or emergency procedures requiring endotracheal intubation were enrolled. Only patients with predicted difficult airways based on EGRI score ≥4 were included. Patients with unstable cervical spine fractures, facial trauma precluding laryngoscopy, known airway tumors, or requiring rapid sequence intubation for life-threatening emergencies were excluded. Participants were randomly allocated into two equal groups using computer-generated block randomization: Group V, intubated using a smart video laryngoscope, and Group M, intubated using a conventional Macintosh laryngoscope. All intubations were performed by anaesthesiologists or emergency physicians with at least two years of clinical experience and who had undergone structured training on both devices before the study period. The patients were preoxygenated for three minutes with 100% oxygen. Standard anaesthesia induction included intravenous fentanyl, propofol,

and rocuronium, with dosages adjusted according to patient weight and haemodynamic status.

All procedures were carried out following standardized airway management protocols. The primary outcome measured was first-attempt intubation success, defined as successful placement of the endotracheal tube with capnographic confirmation. Secondary outcomes included Cormack–Lehane grading, percentage of glottic opening (POGO) score, time to intubation (from insertion of the device into the mouth until confirmed tube placement), number of attempts, need for adjuncts (bougie, stylet), haemodynamic response at baseline, immediately after intubation, and at 1, 3, and 5 minutes, and peri-intubation complications such as hypoxia (SpO_2 < 92%), mucosal injury, esophageal intubation, and dental trauma. All events were recorded in a structured proforma by an independent observer who was not involved in the intubation. The smart video laryngoscope recordings were saved for subsequent review to ensure accuracy of grading and to enable inter-observer reliability assessment. Post-procedure monitoring continued until the patient achieved stable spontaneous ventilation and haemodynamic stability. Data were compiled in Microsoft Excel and later analysed using SPSS software version 22.0. Continuous variables were expressed as mean ± standard deviation and compared using the unpaired t-test, while categorical variables were analysed using Chi-square or Fisher's exact test. A p-value <0.05 was considered statistically significant.

Results:

A total of 120 patients with predicted difficult airways were included, with 60 in each group. Baseline characteristics such as age, gender distribution, BMI, and EGRI scores were comparable between the two groups, indicating good group matching. The smart video laryngoscope demonstrated markedly superior performance, with a significantly higher first-attempt intubation success rate compared to the Macintosh laryngoscope (91.7% vs. 68.3%, p=0.002). The mean time to successful intubation was also significantly shorter in Group V (22.8 ± 5.7 seconds) than in Group M (32.4 ± 7.9 seconds) (Table 1). Glottic visualisation was substantially enhanced with the smart video laryngoscope, reflected by a higher proportion of Grade I–II views and a significantly higher mean POGO score (86% vs. 58%, p<0.001). The requirement for adjuncts such as bougies or stylets was considerably lower in Group V (13.3%) compared to Group M (36.7%) (Table 2). Peri-intubation complications were fewer in the video laryngoscope group, including significantly lower rates of hypoxia, mucosal trauma, and unintentional esophageal intubation (Table 3). No serious adverse events occurred in either group. The improved visualisation offered by the smart device translated into a smoother intubation process with fewer airway manipulations and better haemodynamic stability. Overall, the smart video laryngoscope outperformed conventional laryngoscopy across all major intubation metrics, demonstrating clear clinical advantages in managing predicted difficult airways.

Discussion:

The findings of the present prospective study demonstrate that the smart video laryngoscope outperformed traditional Macintosh laryngoscopy in nearly all aspects of difficult airway management. The significantly higher first-attempt success rate achieved with the video laryngoscope aligns with contemporary evidence showing that enhanced visualisation directly improves intubation success in anatomically challenging airway scenarios. Multiple large prospective and randomized trials have consistently reported superior first-pass success rates with video laryngoscopy in critically ill adults and elective cases with anticipated difficulty, supporting its adoption as a primary device in such situations [5, 6]. The improved glottic visualisation observed in our study characterised by higher Cormack–Lehane grade I–II views and markedly higher POGO scores corroborates earlier work demonstrating that video laryngoscopes overcome the limitations of the three-axis alignment required in direct laryngoscopy [3, 7]. These devices allow clinicians to look around the corner, enabling clearer visualisation even in cases with restricted neck mobility, limited mouth opening, or altered airway anatomy. This visual advantage not only reduces the need for external laryngeal manipulation but also decreases the requirement for adjuncts such as bougies, as seen in our study and supported by findings from previous meta-analyses [8].

Time to intubation was significantly shorter with the smart video laryngoscope, which contrasts with older literature suggesting that video-assisted devices may prolong intubation due to bulkier blades or operator unfamiliarity. Improvements in camera resolution, ergonomics, and angulated blade designs have largely mitigated these limitations. Studies comparing modern-generation video laryngoscopes with Macintosh laryngoscopes have shown that they reduce intubation time, particularly in predicted difficult airways, emergencies, and during cervical spine immobilisation [9]. The shorter intubation time in our study likely reflects enhanced glottic exposure and reduced airway manipulation, which in turn contributed to better haemodynamic stability. Excessive laryngoscopy force and prolonged attempts are known to trigger sympathetic surges, leading to tachycardia, hypertension, arrhythmias, and myocardial stress; therefore, a smoother and faster intubation process is clinically desirable, especially in high-risk patients [10]. The reduction in peri-intubation complications observed in the video

laryngoscope group, including lower rates of mucosal injury, hypoxia, and esophageal intubation, is also consistent with recent systematic reviews demonstrating fewer traumatic events and inadvertent airway misplacement when video laryngoscopy is utilised [11].

Another notable finding of this study is the complete absence of esophageal intubations in the video laryngoscope group, compared with a measurable incidence in the direct laryngoscopy group. Esophageal intubation remains one of the most dangerous complications during airway management, leading to rapid desaturation, aspiration, and cardiac arrest if unrecognised. The enhanced visualisation provided by smart devices substantially mitigates this risk. Additionally, the availability of real-time recording in the smart video laryngoscope allowed for post-procedure review, operator feedback, and quality assurance features increasingly emphasised in modern airway management training. The improved safety profile observed in our study supports growing conclusions that video laryngoscopy should be integrated into routine training curricula for both anaesthesiology and emergency medicine residents [12]. Our results further emphasise the need to consider video laryngoscopy as a standard initial approach in predicted difficult airways rather than a rescue device. This shift mirrors recommendations from emerging airway management guidelines advocating its earlier use. Taken together, the findings of the present study reaffirm that smart video laryngoscopes offer substantial advantages in efficiency, safety, and reliability in managing difficult airways. Their integration into institutional protocols is likely to improve patient outcomes and reduce airway-related morbidity. Future research should explore long-term skill retention, device-related learning curves, and cost-effectiveness analyses in diverse clinical settings.

Conclusion: The present prospective study demonstrated that the smart video laryngoscope significantly outperformed the conventional Macintosh laryngoscope in managing predicted difficult airways. It provided superior glottic visualization, higher first-attempt success, reduced time to intubation, and fewer peri-intubation complications. These advantages translated into smoother airway manipulation and enhanced patient safety. The markedly reduced incidence of hypoxia, mucosal trauma, and esophageal intubation further reinforced its clinical utility. Given its efficiency, reliability, and improved safety profile, the smart video laryngoscope should be considered as a primary device for difficult airway management and incorporated into routine training and institutional airway protocols.

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Table 1: Intubation performance and characteristics among the study members in groups

Outcome	Group V	Group M	p-value
First-attempt success (%)	55 (91.7%)	41 (68.3%)	0.002
Mean time to intubation (sec)	22.8 ± 5.7	32.4 ± 7.9	<0.001
Cormack–Lehane Grade I–II (%)	54 (90.0%)	32 (53.3%)	<0.001
Need for adjuncts (%)	8 (13.3%)	22 (36.7%)	0.003

Table 2: Glottic visualization parameters among the study members in groups

Parameter	Group V	Group M	p-value
Mean POGO score (%)	86 ± 12	58 ± 15	<0.001
Optimized glottic view obtained (%)	51 (85.0%)	29 (48.3%)	<0.001

Table 3: Peri-intubation complications among the study members in groups

Complication	Group V	Group M	p-value
Hypoxia (SpO_2 < 92%)	3 (5)	11 (18.3)	0.02
Mucosal injury	4 (6.7)	13 (21.7)	0.01
Esophageal intubation	0	4 (6.7)	0.04
Dental trauma	1 (1.7)	3 (5.0)	0.31